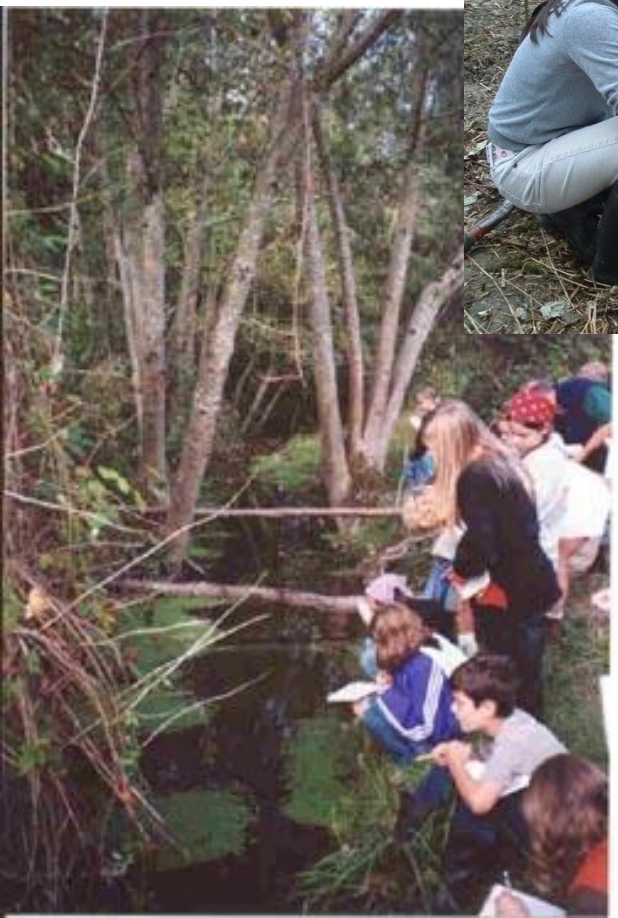
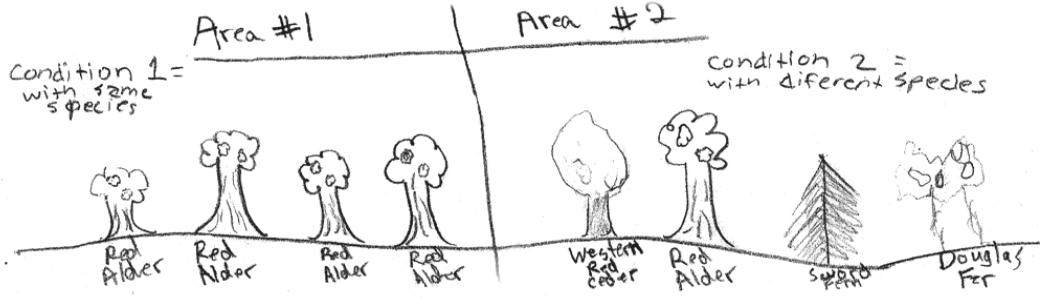
Using Inquiry to Teach Ecology





Presented by Cara Ianni, Education Program Manager
Stilly-Snohomish Fisheries Enhancement Task Force

Science is more than a body of knowledge to be learned, there is a process or method to learn as well (Dewey, 1910).

It is nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of enquiry.

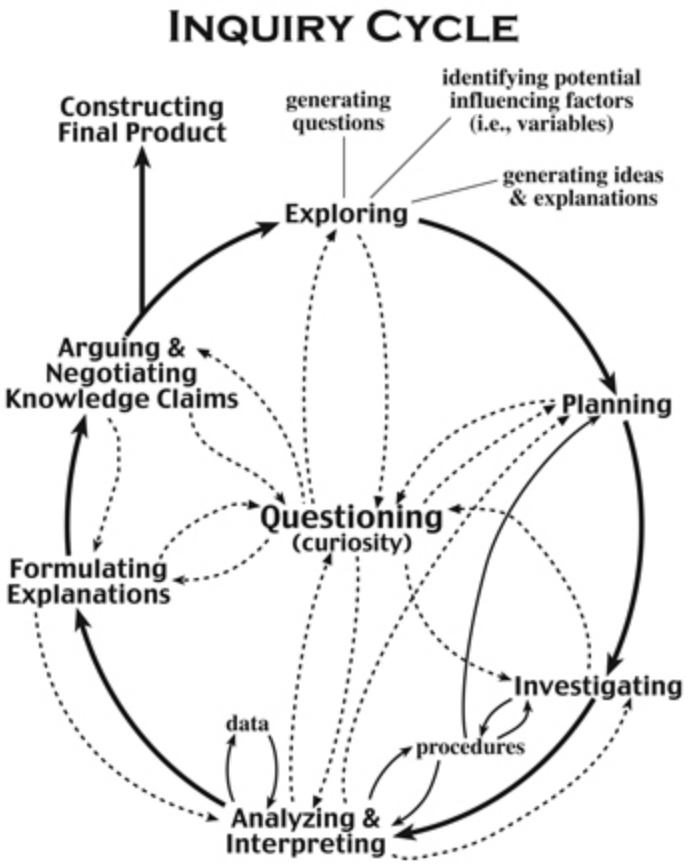
- Albert Einstein, *Ideas and Opinions*

Perhaps the most confusing thing about inquiry is its definition

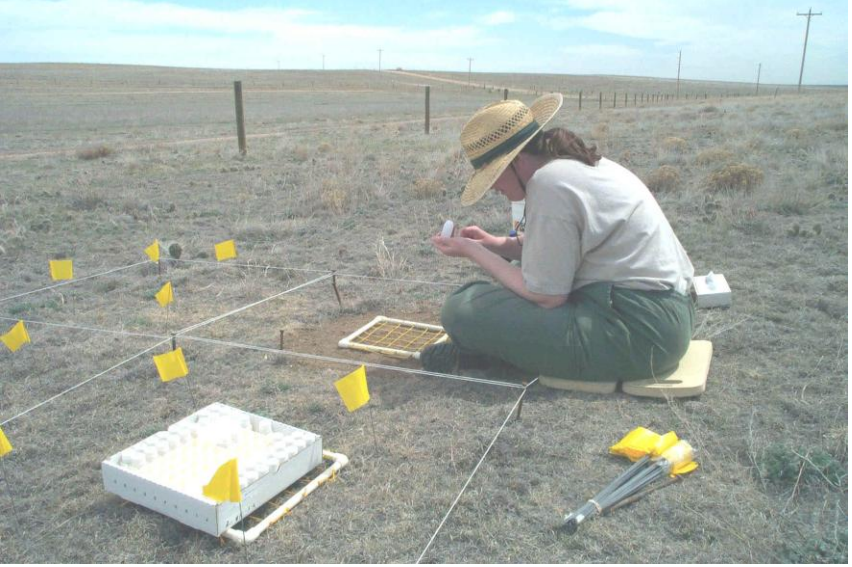
- Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work
- Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

- **Inquiry based approaches to science education focus on student constructed learning as opposed to teacher-transmitted information.**

Inquiry-based Science:



- Inquiry is **student constructed learning** as opposed to teacher-transmitted information.
- **More than just "hands-on"**
- Inquiry is **STUDENT-CENTERED, OPEN-ENDED**, minds-on goodness!
- It is **process oriented**, where students are the problem solvers and the teacher acts as the facilitator rather than presenter.

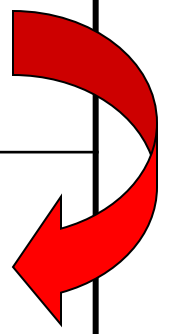


The majority of the concepts we teach in environmental education were learned through ecological *science and research*.

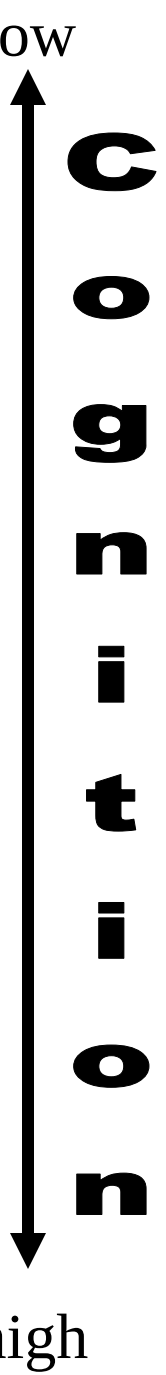
(photosynthesis, food web interactions, interactions between trees and streams…)

Inquiry Continuum

Teacher Delivered (Lecture, Demo)
Cookbook Lab (one procedure produces similar results)
Structured Lab (one procedure produced varied results)
Challenge Lab (varied procedure produced varied results)
Student-directed Inquiry (classroom generates questions, groups determine procedure)
Student-designed Inquiry (Students complete own investigations)



Cognitive Leap



Inquiry Framework: Levels of Student Ownership

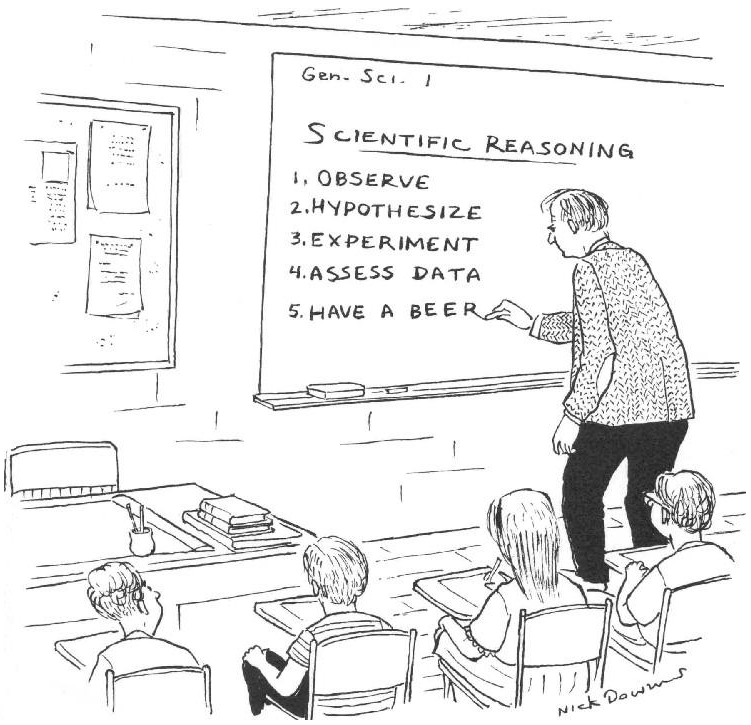
inquiry mode	research question	study system & methods	data collection	analysis & presentation	scholarly goal of the activity
closed-ended demonstration	given	given	given	given	teach existing knowledge by showing or guiding students to it
guided inquiry	given	given	student/ given	student	
bounded inquiry	student/ given	student/ given	student	student	teach the process of knowledge construction
open-ended inquiry	student/ given	student	student	student	
collaboration w/ researcher	given	student/ given	student/ given	student/ given	create knowledge new to discipline

{Sundberg & Moncada 1994, Ohlhorst 1995, D'Avanzo 1996, and Grant & Vatnick 1998}

Teaching Concepts in an Inquiry Framework

- Using geologic models to test the question, "**How do trees affect erosion?**"

- In small groups, students go through the *entire process* of a scientific investigation.



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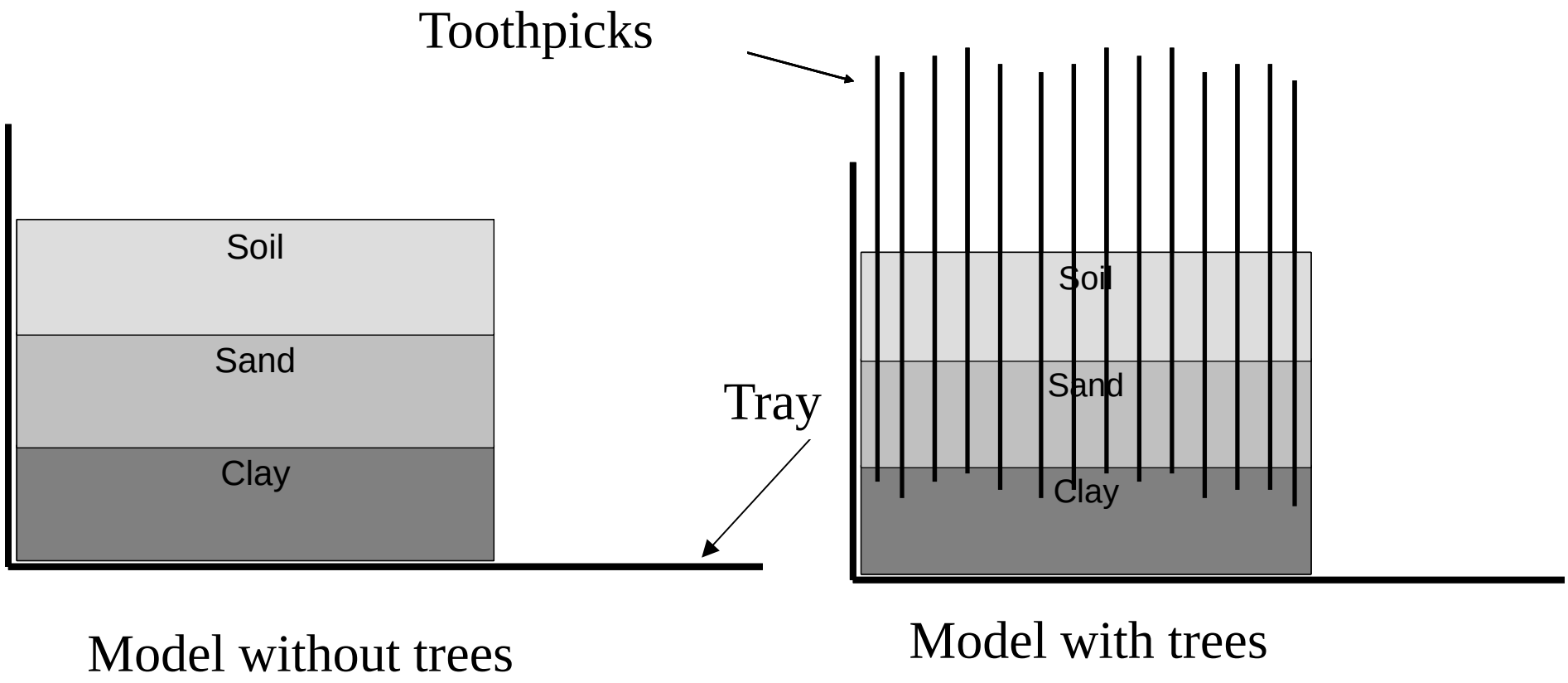
Students add water to “rain” on two models, one with “trees” and one without trees, and measure the amount of soil that washes away



Model without trees

Model with trees

Learning about science & erosion in action!

Station Rotation:

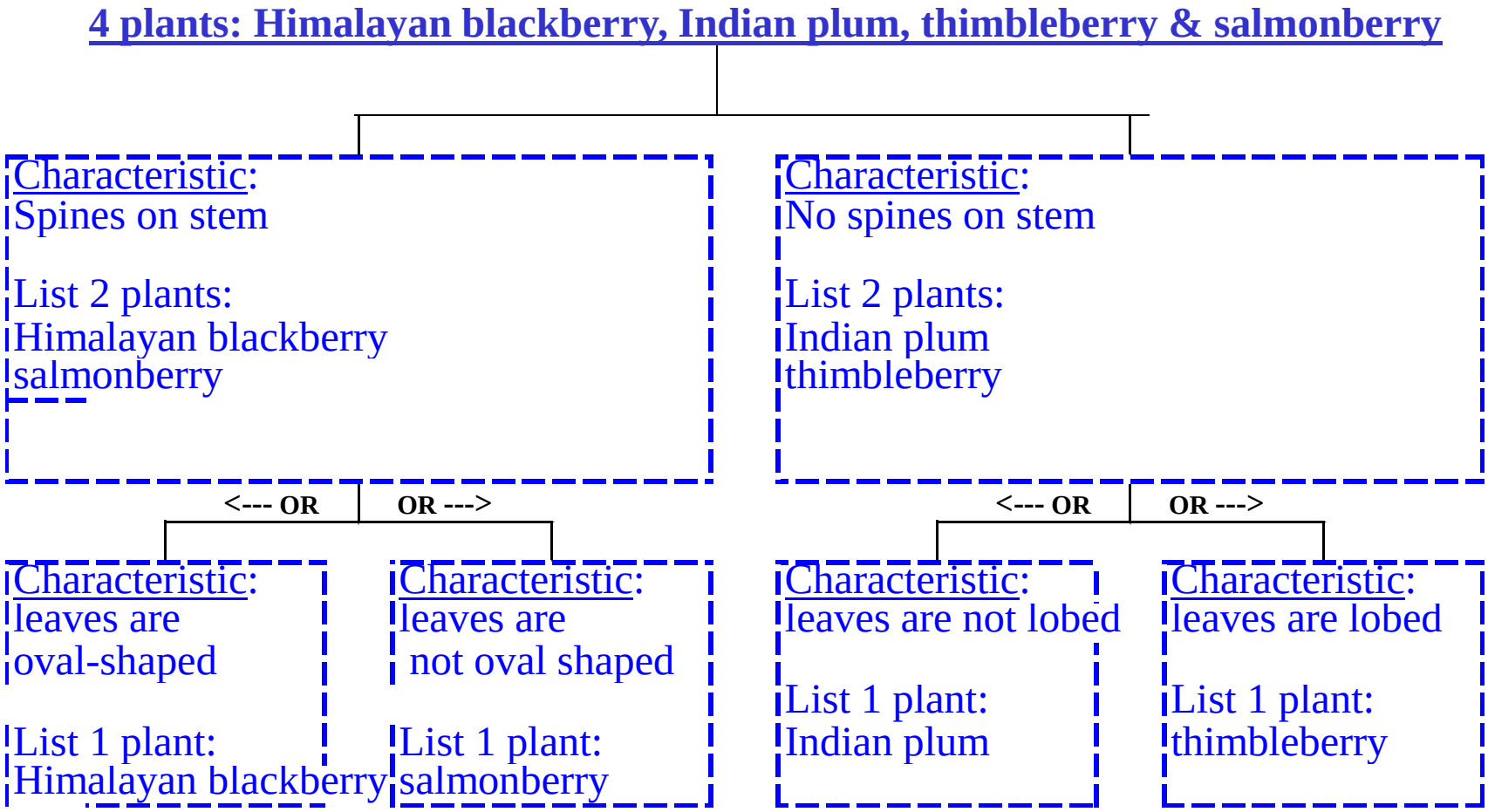
- Animal Adaptations: match inventions with adaptation that may have inspired, and then invent an animal with adaptations to its environment

- Biodiversity: use common household items to model biodiversity concepts such as species richness, community evenness and functional groups (guilds).

- Sorting it Out: Learn plant identification through using and creating keys

Teaching Concepts with an Inquiry Framework

Using and creating keys to sort stream bugs and plants by their physical characteristics:



Students also use choose appropriate plants for their restoration site according to site characteristics (soil moisture, shade) and plant ecology.

Map of Inquiry Structure

Inquiry Starters

Learners explore materials, make observations, and raise questions related to content goals.

→

Focused Investigation

Learners plan and carry out investigations based on their questions.

↓

Sharing Understanding

Learners share investigation results with each other to further their understanding of scientific concepts.

Overall, the inquiry process is driven by the learner's curiosity and sustained by his/her sense of ownership of the process. But curiosity & ownership alone are not enough to ensure that learners have a productive experience that lead to deep understanding of scientific ideas. A well-thought-out structure & guidance provided by the teacher give shape & direction to curiosity with the context of science learning goals.

Students Explore Scientifically Testable Questions (using Inquiry)

- Students are given a sub-sample of ten questions ***that they came up with*** during the watershed tour fieldtrip.
- Students identify scientifically testable and non-testable questions.
- **Change the non-testable questions into testable ones**.
- Students also **identify the manipulated and responding variables** in testable questions.

“How do trees affect erosion” is a testable question – the variables are clear and one could use an experiment to test it.

We ask students to circle the manipulated variable and underline the responding variable, like this:

How do **trees** affect **erosion**?

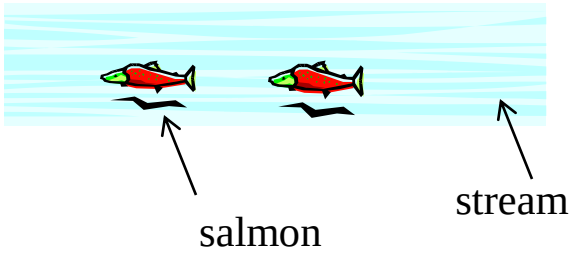
What would happen to the stream-bugs if we cut all the trees?

How does flooding affect water quality?

For all of the testable questions, students then **draw labeled diagrams** and **identify controlled variables**.

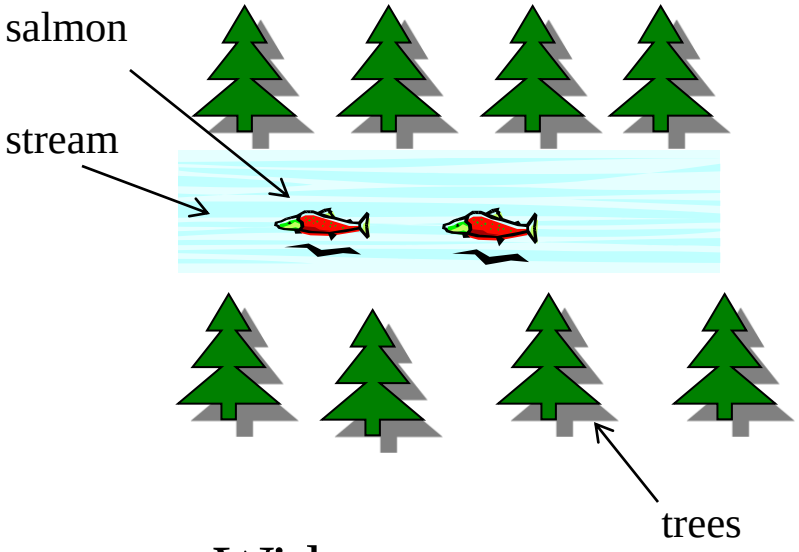
Testable question: What would happen to the salmon population if there were no trees?

Area 1



No trees

Area 2



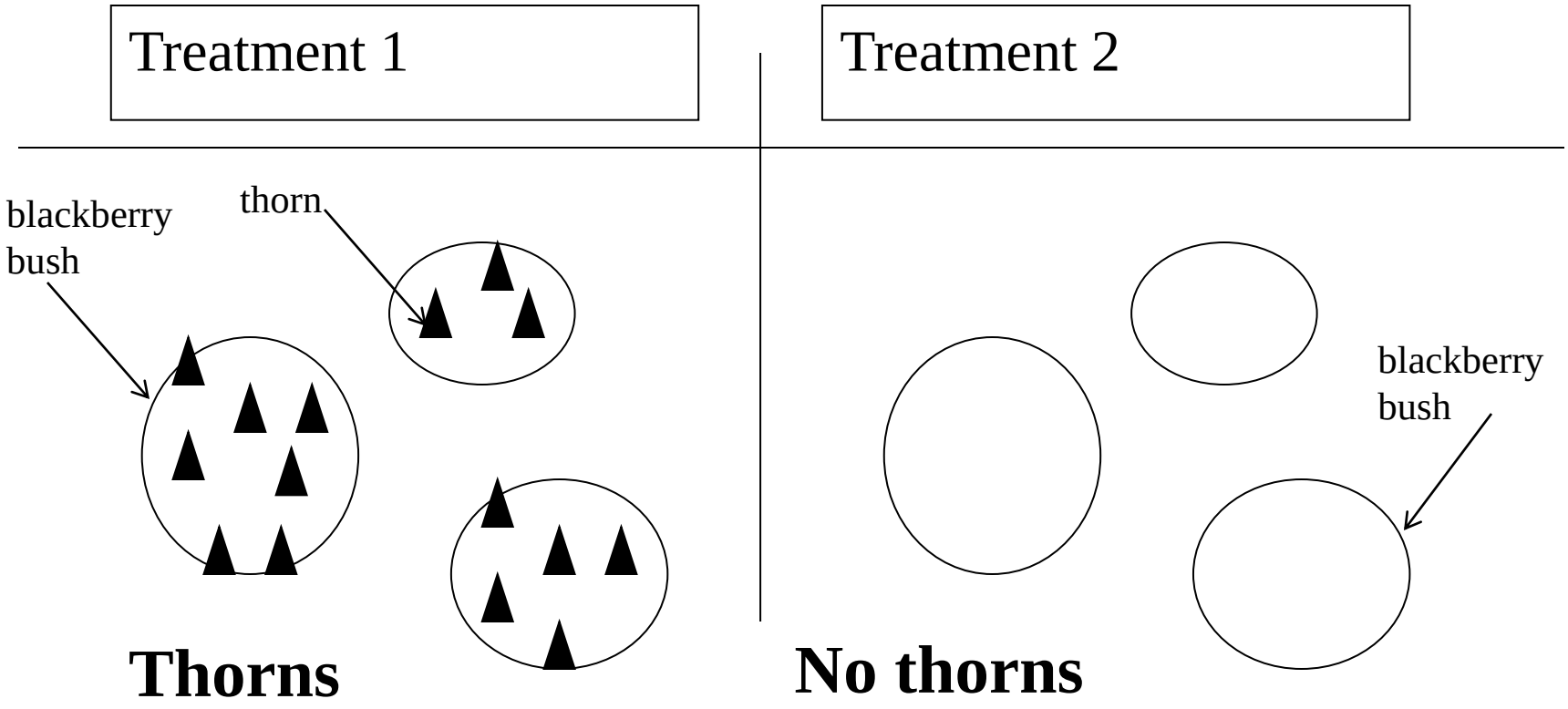
With trees

Next students change "untestable" questions into testable ones

Example: Why do blackberries have thorns? OR Why are there no new trees growing at the restoration site?

- Not testable as written above
- What is your prediction?
- How can you test that?
- Draw a diagram to test that…..

Testable Question: How do **thorns** affect the **amount of blackberry leaves that animals eat**?



Turning Questions: A Variables Scan

The situation…

- Elementary students are exploring how paper towel absorb water
- They notice that paper towels seem to “suck up” the water.
- Someone asks, “Why does the water go into the paper towel?”

(Taken from Institute for Inquiry)

Turning Questions: A Variables Scan

The scan…

- When you "scan" the situation, what variables can you find?
- The explanation must have something to do with how the *water* and the *paper towel* interact, so those are the variables we can change to help us learn more.
- The Variables…
    1. Water (or other liquid)
    2. Paper towel (or other material)

(Taken from Institute for Inquiry)

Turning Questions: A Variables Scan

Turning the Question…

- How can the "why" question be turned into practical action?
- CONSIDER VARIABLE 1: The liquid being absorbed.
  - What could be changed about the liquid?
    - The kind of liquid (tomato juice, motor oil, etc.)
    - The amount of liquid
    - The temperature of the liquid

"WHY DOES THE WATER GO INTO THE PAPER TOWEL?"

Turned Questions…

- Would something different happen if the water were very hot or very cold?
- Would salt water be different from fresh water?
- Would something different happen if we used tomato juice?

(Taken from Institute for Inquiry)

Turning Questions: A Variables Scan

Turning the Question…

- How can the "why" question be turned into practical action?
- CONSIDER VARIABLE 2: The material absorbing the liquid.
  - What could be changed about the paper towel?
    - The brand of paper towel
    - The wetting procedure (pouring water onto the paper, dipping the towel in water, etc)
    - The kind of material (cotton, wool, cardboard, etc.)

"WHY DOES THE WATER GO INTO THE PAPER TOWEL?"

Turned Questions…

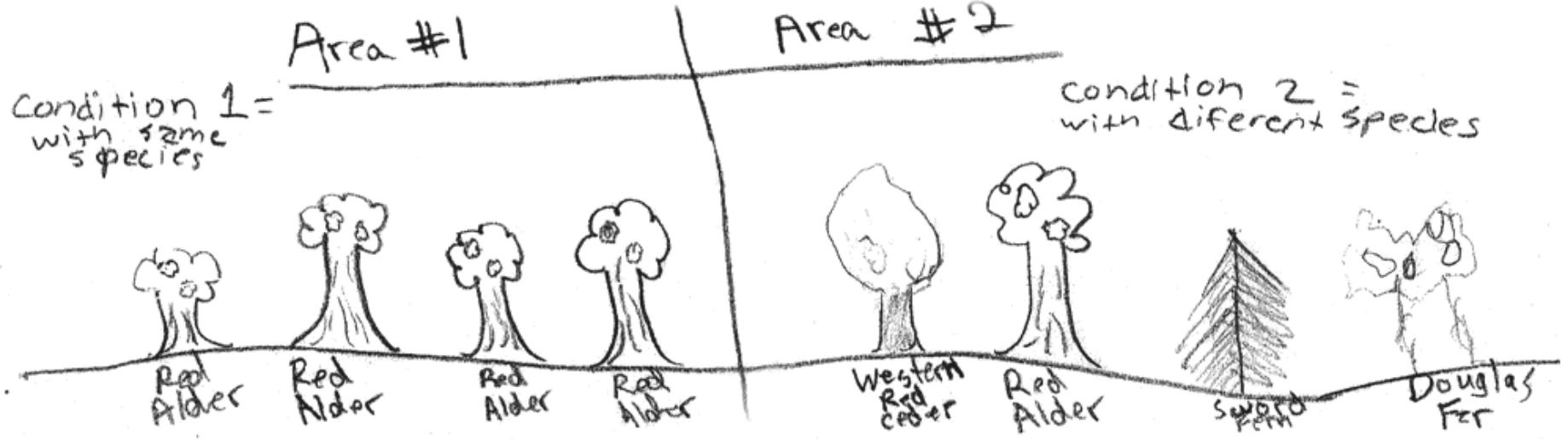
- Does the brand of paper towel make a difference?
- What happens if typing paper is used?
- Does cotton cloth "suck up" water?
- What happens if you stick only the corner of a paper towel in the water?

(Taken from Institute for Inquiry)

Past student questions from REYS that are relevant to stream restoration

- How do different depths of mulch affect the growth of reed canary grass?
- Do plants grow more when they are near their own species or in a diverse community?
- How do different types of plants (i.e. functional groups) affect the growth of invasive ground cover?
- How does saltwater affect the germination of Scotch broom?

Student diagram from "**Do plants grow more when they are near their own species or in a diverse community?**"



View & download Task Force curriculum at:

www.stillysnofish.org/programs/education/index.html

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